Claims

[c1] 1.A method for estimating a temperature profile for individual combustion cans at an inlet of a gas turbine, the method comprising:
determining an exhaust temperature profile of exhaust gas of the gas turbine; and
inputting said exhaust temperature profile into a model-based estimator of turbine components through which turbine gas flows;
wherein said model-based estimator calculates an estimated inlet temperature profile at the gas turbine inlet, based upon said exhaust temperature profile and design parameters of the gas turbine, said estimate inlet temperature profile being indicative of the actual firing temperature of each of the individual combustion cans.

[c2] 2.The method of claim 1, wherein said determining an exhaust temperature profile comprises obtaining exhaust temperature data from a plurality of temperature thermocouples circumferentially disposed about a longitudinal axis of the turbine.

[c3] 3.The method of claim 1, wherein said model-based estimator applies a set of equations for each stage of the turbine, said set of equations relating input temperature, pressure, longitudinal velocity and tangential velocity of the turbine gas to output temperature, pressure, longitudinal velocity and tangential velocity of the turbine gas.

[c4] 4.The method of claim 3, wherein:
each stage of the turbine includes a nozzle section and a bucket section;
the turbine further includes an exhaust diffuser in which said thermocouples are located;
for each of said nozzle sections, said set of equations include a mass balance equation, an energy balance equation and an isentropic relation equation;
for each of said bucket sections, said set of equations include a mass balance equation, a momentum balance equation, and an energy balance equation; and
for said exhaust diffuser, said set of equations includes a mass balance equation a momentum balance equation, and an energy balance equation.

[c5] 5.The method of claim 4, wherein said momentum balance equations for said bucket sections and said exhaust diffuser include angular momentum balance and longitudinal momentum balance.

[c6] 6.A method for estimating a temperature profile for individual combustion cans at an inlet of a gas turbine, the method comprising:
obtaining exhaust temperature data from exhaust of the gas turbine;
normalizing said exhaust temperature data to a reference load condition to obtain a normalized exhaust temperature profile;
inputting said normalized exhaust temperature profile into a model-based estimator of turbine components through which turbine gas flows;
wherein said model-based estimator calculates an estimated inlet temperature profile at the gas turbine inlet, based upon said normalized exhaust temperature profile and design parameters of the gas turbine, said estimate inlet temperature profile being indicative of the actual firing temperature of each of the individual combustion cans.

[c7] 7.The method of claim 6, wherein said normalizing said exhaust temperature data further comprises obtaining exhaust temperature data under varying load conditions.

[c8] 8.The method of claim 7, wherein said normalizing said exhaust temperature data further comprises obtaining exhaust temperature snapshots from a base load and further obtaining exhaust temperature snapshots from progressively smaller loads down to a part load, wherein data from said exhaust temperature snapshots are corrected for mean temperature shift and swirl variation.

[c9] 9.The method of claim 6, wherein said determining an exhaust temperature profile comprises obtaining exhaust temperature data from a plurality of temperature thermocouples circumferentially disposed about a longitudinal axis of the turbine.

[c10] 10.The method of claim 6, wherein said model-based estimator applies a set of equations for each stage of the turbine, said set of equations relating input temperature, pressure, longitudinal velocity and tangential velocity of the

turbine gas to output temperature, pressure, longitudinal velocity and tangential velocity of the turbine gas.

[c11] 11.The method of claim 10, wherein:
each stage of the turbine includes a nozzle section and a bucket section;
the turbine further includes an exhaust diffuser in which said thermocouples are located;
for each of said nozzle sections, said set of equations include a mass balance equation, an energy balance equation and an isentropic relation equation;
for each of said bucket sections, said set of equations include a mass balance equation, a momentum balance equation, and an energy balance equation; and
for said exhaust diffuser, said set of equations includes a mass balance equation a momentum balance equation, and an energy balance equation.

[c12] 12.The method of claim 11, wherein said momentum balance equations for said bucket sections and said exhaust diffuser include angular momentum balance and longitudinal momentum balance.

[c13] 13.A system for estimating a temperature profile for individual combustion cans disposed at an inlet of a gas turbine, comprising:
a plurality of exhaust temperature sensing devices disposed proximate exhaust gas of the gas turbine;
a normalization mechanism for receiving exhaust temperature data from said plurality of exhaust temperature sensing devices, said normalization mechanism producing a normalized exhaust temperature profile with respect to a reference load condition;
a model-based estimator of turbine components through which turbine gas flows, said model-based estimator receiving said normalized exhaust temperature profile;
wherein said model-based estimator calculates an estimated inlet temperature profile at the gas turbine inlet, based upon said normalized exhaust temperature profile and design parameters of the gas turbine, said estimate inlet temperature profile being indicative of the actual firing temperature of each of the individual combustion cans.

[c14] 14.The method of claim 13, wherein said normalization mechanism obtains exhaust temperature data under varying load conditions.

[c15] 15.The method of claim 14, wherein said normalization mechanism said receives exhaust temperature snapshots from a base load and further receives exhaust temperature snapshots from progressively smaller loads down to a part load, wherein data from said exhaust temperature snapshots are corrected for mean temperature shift and swirl variation.

[c16] 16.The method of claim 13, wherein plurality of exhaust temperature sensing devices further comprises a plurality of temperature thermocouples circumferentially disposed about a longitudinal axis of the turbine.

[c17] 17.The method of claim 13, wherein said model-based estimator applies a set of equations for each stage of the turbine, said set of equations relating input temperature, pressure, longitudinal velocity and tangential velocity of the turbine gas to output temperature, pressure, longitudinal velocity and tangential velocity of the turbine gas.

[c18] 18.The method of claim 17, wherein:
each stage of the turbine includes a nozzle section and a bucket section;
the turbine further includes an exhaust diffuser in which said thermocouples are located;
for each of said nozzle sections, said set of equations include a mass balance equation, an energy balance equation and an isentropic relation equation;
for each of said bucket sections, said set of equations include a mass balance equation, a momentum balance equation, and an energy balance equation; and
for said exhaust diffuser, said set of equations includes a mass balance equation a momentum balance equation, and an energy balance equation.

[c19] 19.The method of claim 18, wherein said momentum balance equations for said bucket sections and said exhaust diffuser include angular momentum balance and longitudinal momentum balance.

[c20] 20.A storage medium, comprising:
a machine readable computer program code for estimating a temperature

profile for individual combustion cans at an inlet of a gas turbine; and instructions for causing a computer to implement a method, the method further comprising:

obtaining exhaust temperature data from exhaust of the gas turbine;

normalizing said exhaust temperature data to a reference load condition to obtain a normalized exhaust temperature profile;

inputting said normalized exhaust temperature profile into a model-based estimator of turbine components through which turbine gas flows;

wherein said model-based estimator calculates an estimated inlet temperature profile at the gas turbine inlet, based upon said normalized exhaust temperature profile and design parameters of the gas turbine, said estimate inlet temperature profile being indicative of the actual firing temperature of each of the individual combustion cans.